

University of Dundee

Impact of sociodemographic characteristics of applicants in multiple mini-interviews

Leduc, Jean-Michel; Rioux, Richard; Gagnon, Robert; Bourdy, Christian; Dennis, Ashley

Published in:
Medical Teacher

DOI:
[10.1080/0142159X.2017.1270431](https://doi.org/10.1080/0142159X.2017.1270431)

Publication date:
2017

Document Version
Peer reviewed version

[Link to publication in Discovery Research Portal](#)

Citation for published version (APA):

Leduc, J-M., Rioux, R., Gagnon, R., Bourdy, C., & Dennis, A. (2017). Impact of sociodemographic characteristics of applicants in multiple mini-interviews. *Medical Teacher*, 39(3), 285-294.
<https://doi.org/10.1080/0142159X.2017.1270431>

General rights

Copyright and moral rights for the publications made accessible in Discovery Research Portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from Discovery Research Portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain.
- You may freely distribute the URL identifying the publication in the public portal.

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Impact of sociodemographic characteristics of applicants in multiple mini-interviews

Abstract

Background: Multiple mini-interviews (MMI) are commonly used for medical school admission. This study aimed to assess if sociodemographic characteristics are associated with MMI performance, and how they may act as barriers or enablers to communication in MMI.

Methods: This mixed-method study combined data from a sociodemographic questionnaire, MMI scores, semi-structured interviews and focus groups with applicants and assessors. Quantitative and qualitative data were analysed using multiple linear regression and a thematic framework analysis.

Results: 1,099 applicants responded to the questionnaire. A regression model ($R^2 = 0.086$) demonstrated that being age 25-29 ($\beta = 0.11$, $p=0.001$), female and a French-speaker ($\beta = 0.22$, $p=0.003$) were associated with better MMI scores. Having an Asian-born parent was associated with a lower score ($\beta = -0.12$, $p<0.001$). Candidates reporting a higher family income had higher MMI scores. In the qualitative data, participants discussed how maturity and financial support improved life experiences, how language could act as a barrier, and how ethnocultural differences could lead to misunderstandings.

This is an Accepted Manuscript of an article published by Taylor & Francis in *Medical Teacher* on 26 December 2016, available online:
<http://www.tandfonline.com/10.1080/0142159X.2017.1270431>.

Conclusion: Age, gender, ethnicity, socioeconomic status and language seem to be associated with applicants' MMI scores because of perceived differences in communications skills and life experiences. Monitoring this association may provide guidance to improve fairness of MMI stations.

Keywords: Selection, undergraduate medical education, multiple mini-interviews, gender, ethnicity, socioeconomic status, language.

Glossary term: *socioeconomic status (SES)*

Socioeconomic status is commonly conceptualized as the social standing or class of an individual or group. It is often measured as a combination of education, income and occupation.

Reference: American Psychological Association. [Internet]. Socioeconomic status; [cited 2016 October 7]. Available from: <http://www.apa.org/topics/socioeconomic-status/>

Introduction & background

Since their implementation at McMaster University in 2002 (Eva et al. 2004), multiple mini-interviews (MMI) for selection in medical school have shown to be a reliable way of assessing medical school applicants (Knorr & Hissbach 2014) and are now widely used in North America (Jerant et al. 2015; Reiter et al. 2012), the United Kingdom (Dowell et al. 2012), Australia (Harris & Owen 2007) and some countries of the Middle East (Ahmed et al. 2014; El Says et al. 2013). They are part of a “holistic” approach to admission, which allows a greater emphasis on non-academic attributes (Mahon et al. 2013). These include communication skills, which are central to the interview process (Hecker et al. 2009; Oliver et al. 2014). By relying on such attributes, it is possible to reduce the importance of academic performance in selecting candidates and possibly recruit those from more diverse backgrounds (Powis et al. 2007). This aligns with the increasing importance given to social accountability and diversity in medical school by accreditation organisations (Liaison Committee on Medical Education 2016).

It is therefore important to ensure that MMI do not restrict any attempt to foster diversity in medical school. A recent systematic review has re-emphasized the fact that some subgroups, namely aboriginal and rural applicants, may have difficulties to perform in MMIs (Rees et al. 2016). So far, several studies have reported the impact of demographics such as age, gender, ethnocultural background and socioeconomic status (SES) on MMI scores. Overall, it has been shown that older age (Dowell et al. 2012; Jerant et al. 2015; Jerant et al. 2012; Raghavan et al. 2013; Reiter et al. 2012) and female gender (Barbour &

Sandy 2014; Dowell et al. 2012; El Says et al. 2013; Griffin & Hu 2015; Jerant et al. 2015; Jerant et al. 2012; Raghavan et al. 2013) can be associated with higher MMI scores in some settings. While most of the studies looking at SES did not find any correlation with MMI performance (Griffin & Hu 2015; Jerant et al. 2012; Reiter et al. 2012; Taylor et al. 2015; Uijtdehaage et al. 2011; Wilson et al. 2009), one recent study in the USA has shown that an individual socioeconomic indicator could be associated with MMI scores (Jerant et al. 2015). A critique of these studies is that they provided little evidence into *how* these characteristics could act as barriers or enablers in the MMI process. Moreover, these studies did not include any data on language as a distinct variable. A study by Kelly et al. (2014) did observe that non-native English speakers had lower MMI scores and that culture and language could create barriers, misunderstandings, or increase stress. However, this study used a simulated MMI with a small sample of admitted medical students. Therefore, the stakes of the assessment were reduced and arguably only the top performers out of all the applicants were included in this sample. These factors could have minimised the observed effects that might be seen under real exam conditions with a full spectrum of applicants.

Consequently, the association between some sociodemographic characteristics and performance in a “real-life” MMI remains to be explored. Moreover, no studies have looked so far at the association between language and MMI performance in a non-English-speaking setting. One model that may provide further insight into how these demographics may play a role is the communication model. As communication is a central component of MMI, it can be considered as an exchange between an applicant and an assessor taking place in a given context (i.e. MMI station). Indeed, both send (“encode”) and receive

(“decode”) information and influence each other through feedback. Moreover, an array of factors may act as barriers or enablers to communication. For instance, in MMI as in any communication interaction, barriers (“noise”), either psychological (e.g., preconceived ideas, prejudice, etc.), semantic (e.g., language differences or jargon) or physical (e.g., hearing impairment) can lead to a poorer exchange and, possibly, poorer results (DeVito 2013).

The goal of this study is therefore to look at the association between applicants’ demographics and MMI score, highlighting how communication within MMI may, or may not, be linked with factors such as age, gender, ethnicity, language, or SES.

The research questions are:

Q1: Are sociodemographic characteristics of applicants, specifically age, gender, language, ethnocultural background and socioeconomic status correlated with performance across MMI? If so, how?

Q2: How might these sociodemographic characteristics act as barriers or enablers to communication in MMI?

Methods

Context

The three Canadian French-speaking medical schools use a yearly, centralised interview process called the *Integrated Francophone Multiple Mini Interviews* (IFMMI) conducted

simultaneously across 4 different sites in Canada (Montréal, Québec City, Sherbrooke and Moncton) over the same weekend. MMI were already deemed feasible and reliable in the French Canadian context (St-Onge et al. 2009) and IFMMI have shown predictive validity with clerkship scores (Renaud et al. 2016). Its overall internal consistency (Cronbach alpha) has varied between 0.68 and 0.75 in the last 7 years. The IFMMI consist of twelve, 7-minute stations aimed at assessing different “non-academic” attributes adapted from the CanMEDS competency framework (Frank et al. 2015), such as collaboration or communication. In the stations, applicants are either interviewed by an assessor or they interact with an actor, and are then assessed using a standardised marking sheet on a scale from F (5 points) to A (30 points). This study focused only on the candidates assessed at the Montreal interview site.

Study design and methodology

This cross-sectional study lies in a pragmatic paradigm (Maudsley 2011) and relies on mixed methods combined using an explanatory model (Bryman 2006), where qualitative data are used to explain findings from concurrently collected quantitative data. It took place over two years. In 2014, a sociodemographic questionnaire for applicants was collected. In 2015, data collection included a questionnaire and also interviews and focus groups for applicants and assessors. All parts of this study were approved by Université de Montréal’s ethics review board for research in Health Sciences.

Recruitment and data collection

In 2014 and 2015, applicants were recruited at the Montreal interview site after their MMI was completed to avoid any interference with the interview process. Those willing to participate were invited to fill a consent form and a sociodemographic questionnaire including questions about age, gender, language, country of origin, postcode, and parental education level. In 2015, applicants were also invited to take part in semi-structured interviews. It was explicitly mentioned that participation to this project was optional, and would have no impact on the selection process. The main researcher and collaborators were part of the admission committee, but were not conducting any MMI interviews and were not involved in admission decisions. Participants were offered to take this post-MMI interview either in French or in English, to allow them to use the language they were the most comfortable with. The main researcher, who is fluent in French and English, ensured that the interview guide's meaning was similar in both languages. Interviews were conducted either during the MMI weekend (n=16) or the following week via Skype (n=3), either by the main researcher (JML) or a collaborator (RR). Their length ranged from 14'33'' to 34'04'' (mean 21'55''). One interview was conducted in English and all the others in French.

In 2015, assessors were recruited to take part in focus groups. Aiming for purposive sampling, one focus group included assessors from the community (n=4) and one included residents and attending physicians (n=4). One was conducted at the end of each day of the MMI weekend for practicality, and to ensure that there was no impact on the scoring pattern

of interviewers. Focus groups relied on a similar interview guide as the semi-structured interviews and were conducted in French.

Quantitative data analysis

Sociodemographic data of applicants were anonymously combined with their MMI scores. Statistical analyses were done using SPSS (version 20.0). Using their postcode, a material deprivation quintile was attributed to each participant based on their census dissemination area (aggregated data from 400-700 people). This indicator is used for public health initiatives and is based on high school completion rate, ratio of employment and average personal income (Pampalon et al. 2012). These align well with traditional measures of socioeconomic status (Grbic et al. 2015).

For analysis purposes, it was decided to group the applicants' and their parents' country of birth into broader categories using their corresponding subcontinent of birth, as defined by the United Nations (2014). These included East, South and Southeast Asia as "Asia" (Office of Minority Health - U.S. Department of Health and Human Services 2014), North Africa and Middle East, which are traditionally associated with people of Arab origins (Asi & Beaulieu 2013), Europe, and North America. All other origins, because of their low numbers, were grouped as "others".

Statistical models

Statistical tests were initially conducted for each individual variable regarding their association with MMI scores. Tests included either a Student's t-test for mean comparison

between dichotomous groups, one-way ANOVA for mean comparison of categorical variables and Pearson's correlation coefficients for continuous variables. Results were considered statistically significant for p values <0.05 .

Then, a general linear model was built using ANOVA to predict the dependent variable (total MMI scores) using the significant independent variables (sociodemographic characteristics) identified previously. All significant variables were forced into the model, and then only significant predictors were retained. Afterwards, first-level interactions were checked between the remaining variables and were incorporated in the model, if significant. Finally, a linear regression model was created with the significant variables and interactions. Missing data were excluded on a case-wise basis. Additional one-way ANOVA were performed on the 2015 cohort, as some additional data regarding family income and ethnicity was available in their questionnaire.

Qualitative data analysis

Interviews and focus groups were anonymised and transcribed using ExpressScribe (version 5.73) in their original language, since translation to another language can lead to a loss of meaning (Smith et al. 2008). A sample of the transcripts was checked by two research colleagues (RR, AD) for accuracy. Then, the research team used a sample of three semi-structured interviews and one focus group to generate the initial coding framework. Inductive and deductive analytical approaches (e.g. comparisons to the communication model (DeVito 2013)) were used to inform the coding framework which was developed into both an English and French version. The framework was revised twice and the final

version was bilingual, with expressions that retained as much as possible the same meaning in both languages.

The main researcher (JML) then coded all the data using the thematic framework (Braun & Clarke 2006; Green & Thorogood 2013) with ATLAS.ti (MAC version 1.0.24). Parallel coding was done for one semi-structured interview by two researchers (JML & RR), to check the coding framework. Only relevant quotations were translated and were then double-checked by a professional translator for accuracy.

Results

Quantitative data

Participants characteristics

In 2014 and 2015, 568 (97.3% response rate) and 531 (90.6% response rate) candidates gave informed consent and responded to the sociodemographic questionnaire, respectively.

Table 1 shows the characteristics of both cohorts, which were very similar. Further analyses, unless otherwise stated, were made on the combined sample of 2014 and 2015.

[Insert Table 1 about here]

The median age of applicants was 20 years old (range 17-42). Most of the candidates were born in North America ($n=922$, 83.9%) or had at least one parent born in North America ($n=798$, 72.6%), spoke most often French at home ($n=877$, 79.8%), lived in a large city ($n=942$, 85.7%) and had at least one parent with a university degree ($n=860$, 78.3%). The applicants living in the least deprived dissemination areas were over-represented ($n=317$,

28.8%) compared to the other quintiles. Data collected in 2015 showed that the majority of applicants reported an annual income over C\$100,000 ($n=398$, 75.0%).

MMI scores

MMI scores ranged from 120 to 325 (theoretical maximum = 360). There was no statistically significant difference between mean interview scores in 2014 compared to 2015 (238.3 vs. 241.7 $p=0.079$). Also, no significant difference was observed between the score for each day of interview either in 2014 or 2015. Internal consistency (Cronbach's alpha) was 0.707 in 2014 and 0.712 in 2015 for the sample of participants who responded to the questionnaire.

Linear regression model

A linear regression model showing the significant predictors of MMI score for 1,083 applicants (sixteen applicants were excluded from the final model because of missing data) from the two cohorts is presented in **Table 2**. It shows that the subgroup of candidates aged 25-29 years old performed significantly better and that those who had at least one parent born in Asia (East, South and Southeast Asia) had a significantly lower score. A significant interaction was found between gender and language. Therefore, female candidates performed better in MMI, but only in the subgroup of people who reported French as the most spoken language at home ($n=877$). No significant effect of candidates' country of birth, parental education level, material deprivation quintile or size of community or residence could be found and they were not included in the final model. The linear regression model explained 8.6% of the variance in MMI scores (adjusted R^2).

[Insert Table 2 about here]

In the 2015 data, a one-way ANOVA showed that, although there was no difference between the scores in different deprivation quintiles, candidates who had declared a parental income > C\$250,000 had significantly higher MMI scores ($M=252.8$) than the candidates who declared C\$100,000 to C\$249,999 ($M=243.3$; $p=0.035$) or who declared less than C\$100,000 ($M=237.1$; $p<0.001$). Also, in accordance with our findings related to parental origin, candidates who self-declared “Chinese” ($n=29$, $M=227.1$; $p=0.013$) or “Southeast Asian” ($n=20$, $M=220.5$; $p=0.003$) had significantly lower scores than those who declared any other ethnocultural background ($M=242.5$). Overall, people who self-declared “White/Caucasian” had a higher score ($M=245.2$) than the others ($M=238.1$; $p=0.012$). No such significant differences could be observed with any other ethnic group taken individually.

Qualitative data

Demographics of the participants for the qualitative strand are presented in **Table 3**.

[Insert Table 3 about here]

Four main interrelated themes emerged from the data through our thematic framework analysis. The first theme referred to the “design” of our MMI and linked to the contextual aspect of the communication model. It included the importance of standardisation, time limit, content and its perceived relevance (instructions, questions and assessment criteria). The second theme was how characteristics of participants, such as age, gender, language, ethnicity or socioeconomic background might influence the quality of communication within MMI. The third theme was how assessors’ characteristics might influence this

interaction. It provided interesting data about their expectations and approach to assessment. These two themes referred to the characteristics of the applicant and the assessor as sender/receiver in the communication model. The final theme was related to the interactions between the assessor and the applicant, i.e., the perceived applicants' stress toward the reaction of an assessor or actor, or the perceived cultural differences between assessors and interviewees. It related largely to ideas of encoding, decoding and feedback in the communication model. A short description of how each sociodemographic characteristic can be perceived as a barrier or an enabler will now be presented in light of these four themes.

Age, maturity, socioeconomic status and the importance of life experiences

Being older and more mature was perceived as beneficial by candidates, because it could boost self-confidence and reduce the anxiety associated with the interview process (**Table 4, #1**). For some assessors, applicants' maturity was also associated with greater communication skills (**Table 4, #2**). Self-perceived maturity appeared to be driven by past experiences, such as travels, work, school and hobbies, which provided more elements to discuss in MMI stations. Many applicants also mentioned that the higher socioeconomic status of their parents allowed them to acquire more life experiences (**Table 4, #3**). One assessor also explained how a lower SES, and the need to work to pay for tuition fees, could have an impact in a station about volunteering (**Table 4, #4**).

Gender

About half of the interviewed applicants believed that there was a difference in the way men and women would approach the stations, especially regarding empathy (**Table 4, #5**). Most of the assessors shared this view and mentioned that women were better at establishing a caregiving relationship in the stations, such as comforting someone, or trying to understand someone's problems. A few candidates mentioned that gender similarity between the applicant and the actor could have an impact on their behaviour, highlighting how the actors' characteristics and the way they are integrated in station design may play a role in the interaction (**Table 4, #6**).

Language

Overall, language was largely discussed in the data. Applicants explained how language issues could create barriers at different levels in MMI. Understanding the station instructions could sometimes be challenging for non-native French speakers (**Table 4, #7**). Language difficulties could increase the amount of time required to say things within the limited timeframe of MMI, and also increase stress for non-native French speakers. Because of this language barrier, the assessors also perceived the interaction as less fluent (**Table 4, #8**). This related largely to the concept of "semantic noise" in the communication model.

Participants, both native and non-native French speakers were also shy of asking about the meaning of certain words, with fear of being negatively judged by assessors by doing so.

Indeed, some assessors mentioned how their expectations regarding language could make them less “flexible” regarding language issues (**Table 4, #9**).

Ethnocultural background and cultural values

People who were born abroad, apart from language issues, usually considered it as a positive asset for MMI stations. It was described as something that helped them foster personal qualities such as open-mindedness, and provided them with greater personal experience (**Table 4, #10**). This view was also shared by assessors, especially regarding a station related to multiculturalism.

Ethnocultural differences could also act as a barrier when the interviewer felt that they were unable to correctly and fairly assess the candidates based on their own set of cultural values. As an example, some assessors mentioned that people with an Asian background were sometimes a bit more difficult to “read” and seemed shy than other candidates (**Table 4, #11**).

[Insert Table 4 about here]

Discussion

To our knowledge, this is the first mixed-method study done in a real-life exam setting to explore the association between performance and sociodemographic characteristics of applicants in MMI. Our multiple regression model demonstrated that the sociodemographic variables had a significant, although small, correlation with MMI scores across two different cohorts. A few marks can indeed make a difference between an

admission offer or a rejection for many candidates. For example, in our setting, using a threshold MMI score one standard deviation below the mean, a variation in score equivalent to 8% of the variance could impact decision for up to 11.5% of applicants. The presence of significant statistical interactions between some of these variables also highlighted how these characteristics may be interrelated. In our qualitative data, applicants and assessors did perceive that sociodemographic characteristics could have an impact on the MMI performance, and act as barriers or enablers either through the contextual elements of MMI, or specific elements related to the interaction (encoding, decoding, noise, feedback, etc.) that can be linked to the communication model. A summary of our findings answering the research questions (Q1 and Q2) is provided in **Table 5**.

[Insert Table 5 about here]

Age, maturity and SES

Our data suggest that the positive associations observed between higher age or SES and MMI score is perceived to be explained by more numerous life experiences, providing more material to discuss in MMI stations and better skills to discuss them. For age, this likely aligns with the wish of many medical schools to select more mature students (Albanese 2013). However, the association found in 2015 between higher parental income and better MMI scores can be a cause of concern, since our institution, among many other medical schools, want to admit more people from lower socioeconomic background (Mathers & Parry 2009). Another recent study also suggested that higher SES could be associated with higher MMI scores (Jerant et al. 2015) when assessing individual deprivation level. Firstly, this suggests that relying on area-based indicators may be misleading, because they rely on aggregated rather than individual data (Morgenstern

1982). Secondly, our qualitative data suggest that drawing on life experiences such as volunteering or traveling is likely to favour people who were financially supported by their parents.

Gender

Our study demonstrated that, in our setting, women had higher MMI scores. The largest Canadian study on MMI did not find any difference between genders (Reiter et al. 2012), but did not include French-speaking medical schools. Therefore, one could wonder if this is a “Francophone” specificity, as the proportion of women entering medical school is significantly higher in Québec than in the rest of Canada (Association of Faculties of Medicine of Canada 2014). The observed interaction between gender and French language may indeed suggest that an underlying cultural specificity is attached to language in Canada (Thomson 1995), and that perhaps French-speaking women share different attributes than their non-French speaking counterparts. It is also possible that our MMI favour a “feminine” communication style, which is usually considered as more “patient-centered” (Roter & Hall 2004). Assessors in our focus groups indeed mentioned that women seemed better at establishing a caregiving relationship and showing empathy. It remains however unclear if, in our setting, this was based on actual observations or preconceived ideas, yet both could impact scores. Although the impacts of a feminised medical profession remain a matter of debate (Phillips & Austin 2009), the focus on perhaps less “feminine” constructs will warrant further exploration in our context.

Ethnocultural background

The lower scores obtained by applicants with an Asian background (East, Southeast or South Asia) seem to drive the difference observed between “White/Caucasian” and any other ethnicity category. It may possibly be explained by cultural stereotyping or differences in communication style. For instance, in the qualitative interviews, some of the assessors mentioned that they encountered the stereotype of the “shy Asian”, which was also thoroughly described by medical students and teachers in a study looking at the underperformance of ethnic minorities in medical school in the UK (Woolf et al. 2008). According to the communication model, such stereotyping could be considered “psychological noise” and contribute to impair communication in MMI. There is also evidence that Asian-American self-report the use of a less “open” or less “emotional” communication style than European-Americans (Park & Kim 2008), which may make it more difficult for some assessors to assess applicants with an Asian background. Therefore, it seems highly relevant to discuss cultural differences during interviewer training, at least to make them aware of this possibility.

Language

Our study is the first to explore the association between language and MMI score in a non-English speaking setting. A significant difference in MMI score was observed between people who spoke mostly French at home and those who did not. Although it remains challenging to distinguish language from culture (Risager 2012), our regression model suggests that, for some participants, both have an independent association with MMI score. Our qualitative data also supported the importance of language across MMI, mostly by

explaining how language difficulties could act as barriers throughout the process. This aligns well with the findings of Kelly et al. (2014), who demonstrated an association between International English Language Testing System (IELTS) scores, MMI performance and first year medical school results. Since language is key to communication, it is likely that language proficiency plays an important role in any MMI context, and later on in clinical practice (Mustajoki et al. 2015). However, non-native French speakers will arguably improve as they study medicine in French. It seems therefore relevant to minimise linguistic bias by using a clear and unambiguous language, as suggested by Kelly et al. (2014) and by emphasizing a non-judgmental attitude from assessors if applicants ask about French words or expressions.

Strengths and limitations of the study

The high response rate and the combination of two comparable consecutive cohorts have allowed us to have a large sample size for the quantitative strand. For the qualitative strand, the sampling variety of stakeholders (applicants, assessors) has provided a content-rich qualitative data collection and opportunity for triangulation of themes (Giddings & Grant 2009). For the data analysis, the coding framework was built in an iterative fashion with part of the research team, allowing for exchange and critical reflection. Most of the analysis was done on the original French data, so that misunderstandings or ambiguity related to translation were avoided (van Nes et al. 2010). Finally, the use of mixed methods in this study also helped us to better understand the findings of the quantitative strand, while providing guidance for improvements in the MMI process.

This study also has several limitations. Many postcodes were missing, especially in 2014. However, since no effect of the material deprivation index was found in one-way ANOVA, it was not included in the multiple regression model, and therefore greatly minimised the number of missing data in the results presented.

Regarding our qualitative data, the use of a convenience sample might not be fully representative of the whole applicants' population. For instance, certain groups, such as individuals from an Asian background, were not represented within the qualitative data. This limits the explanations that can be provided on their lower MMI score. Also, a social desirability bias may have happened when talking about socially sensitive issues such as ethnocultural differences (Krumpal 2013). However, we did find a variety of contrasting opinions in our interviews, which allowed us to capture data that was likely not always influenced by this bias.

Station design varies between medical schools, therefore generalisation of our results, which is a single-centre study, must be done with caution. MMI should not be considered as a “monolithic block” and will vary depending on implementation and content (Eva & Macala 2014). However, we do believe that, although the MMI process will have different iterations across medical schools, there is a set of common traits among them (station topics, time-pressure, language importance) that will make our findings useful to other institutions.

Care must also be taken regarding differences in ethnocultural groupings, which, in any context, remain arbitrary. For example, the distribution of people within the “Asian” category will differ between countries (Aspinall 2003) and between Canadian provinces (Statistics Canada 2016). Therefore, data would need to be monitored locally before generalising any associations. However, communication is at the very centre of MMI, and therefore noise and misunderstandings based on culture or language are likely to occur in most settings.

Recommendations for further studies

An important need would be to better understand the association between sociodemographic characteristics and performance in medical school and clinical training. Some authors have shown that, in undergraduate settings (McVeigh & Dunne 2014) and postgraduate settings, females still perform better than males (Brandt et al. 2013). Longitudinal, large-scale studies are needed to see if this finding is consistent. If women perform better in MMI, it could be because MMI are correctly predicting their better performance in medical school, clinical rotations, or perhaps clinical practice. Similarly, it is important to clarify to what extent language proficiency is predictive of later performance in medical school and also if certain types of stations may be more strongly affected by language skills.

Conclusion

Our results showed that, in French Canadian MMI, older age, female gender, being a French-speaker, and having a higher SES, were positively correlated with an applicants’

results. On the contrary, being of Asian origin (East, South, Southeast Asia) was associated with a lower score. We have also shown that qualitative data can help us understand how these characteristics may act as enablers or barriers by creating noise, improving or impairing message transmission, while being modulated by the context of the MMI station.

Therefore, although MMI represent a significant improvement over the traditional one-on-one admission interviews in terms of reliability, it remains a communication interaction that can be modified by many factors, some of them likely to be irrelevant for selection into medical school and perhaps not predictive of medical school outcomes. Although some of these associations, such as language proficiency, might be unavoidable, medical schools need to be aware of them, monitor them and do their best to minimise their impact on the fairness and validity of the selection process. After all, MMI play a significant role in shaping tomorrow's medical workforce and deserve careful scrutiny.

Acknowledgements

The authors would like to thank Dr. Julie-Anne Buckland for her help with data collection and initial project planning in 2014. Thanks to Dr. Albaka Ag-Bazet who also provided comments for the questionnaire content. Special thanks to Mrs. Ive Cartier who did proof-reading of the translated quotes.

Declaration of Interest

This study received no financial support.

The authors report no declarations of interest.

Word count: 4710 (excluding abstract, acknowledgements, declaration of Interest, tables and abstract)

References

- Ahmed A, Qayed KI, Abdulrahman M, Tavares W, Rosenfeld J. 2014. The multiple mini-interview for selecting medical residents: first experience in the Middle East region. *Med Teach*. 36:703-9.
- Albanese M. 2013. The possible impact of the MMI and GPA on diversity. *Acad Med*. 88:152-3.
- Asi M, Beaulieu D. [Internet]. Arab Households in the United States: 2006-2010; [cited 2016 Oct 9]. Available from: <http://www.census.gov/prod/2013pubs/acsbr10-20.pdf>
- Aspinall PJ. 2003. Who is Asian? A category that remains contested in population and health research. *J Public Health*. 25:91-97.
- Association of Faculties of Medicine of Canada. [Internet]. Canadian Medical Education Statistics 2014; [cited 2016 Oct 9]. Available from: www.afmc.ca/pdf/CMES2014-Complete-Optimized.pdf
- Barbour ME, Sandy JR. 2014. Multiple mini interviews for selection of dental students: influence of gender and starting station. *J Dent Educ*. 78:589-96.
- Brandt JS, Kramer SE, Chosen ST. 2013. Academic Differences Among Male and Female Candidates Applying for Obstetrics and Gynecology Residency: The Experience of One Program. *J Surg Educ*. 70:439-442.
- Braun V, Clarke V. 2006. Using thematic analysis in psychology. *Qual Res Psychol*. 3:77-101.
- Bryman A. 2006. Integrating quantitative and qualitative research: how is it done? *Qual Res*. 6:97-113.
- DeVito JA. 2013. The interpersonal communication book. Boston: Pearson.
- Dowell J, Lynch B, Till H, Kumwenda B, Husbands A. 2012. The multiple mini-interview in the U.K. context: 3 years of experience at Dundee. *Med Teach*. 34:297-304.
- El Says F, Ayuob N, Fahmy AR, El Fayez F, Hasanian M, El Deek B. 2013. Experience of establishment of multiple mini structure interview as part of student admission policy at Faculty of Medicine, King Abdulaziz University, 2011-2012. *Med Teach*. 35:S74-S77.
- Eva KW, Macala C. 2014. Multiple mini-interview test characteristics: 'tis better to ask candidates to recall than to imagine. *Med Educ*. 48:604-13.

- Eva KW, Rosenfeld J, Reiter HI, Norman GR. 2004. An admissions OSCE: the multiple mini-interview. *Med Educ.* 38:314-26.
- Frank JR, Snell L, Sherbino J, editors. 2015. *CanMEDS 2015 Physician Competency Framework*. Ottawa: Royal College of Physicians and Surgeons of Canada. p. 29.
- Giddings LS, Grant BM. 2009. *Mixed methods research for nursing and the health sciences*. Chichester, West Sussex: Wiley-Blackwell. Chapter 7, From Rigour to Trustworthiness: Validating Mixed Methods; p. 119-134.
- Grbic D, Jones DJ, Case ST. 2015. The Role of Socioeconomic Status in Medical School Admissions: Validation of a Socioeconomic Indicator for Use in Medical School Admissions. *Acad Med.* 90:953-60.
- Green J, Thorogood N. 2013. *Qualitative methods for health research*. London: SAGE.
- Griffin B, Hu W. 2015. The interaction of socio-economic status and gender in widening participation in medicine. *Med Educ.* 49:103-113.
- Harris S, Owen C. 2007. Discerning quality: using the multiple mini-interview in student selection for the Australian National University Medical School. *Med Educ.* 41:234-41.
- Hecker K, Donnon T, Fuentealba C, Hall D, Illanes O, Morck DW, Muelling C. 2009. Assessment of applicants to the veterinary curriculum using a multiple mini-interview method. *J Vet Med Educ.* 36:166-73.
- Jerant A, Fancher T, Fenton JJ, Fiscella K, Sousa F, Franks P, Henderson M. 2015. How Medical School Applicant Race, Ethnicity, and Socioeconomic Status Relate to Multiple Mini-Interview-Based Admissions Outcomes: Findings From One Medical School. *Acad Med.* 90:1667-74.
- Jerant A, Griffin E, Rainwater J, Henderson M, Sousa F, Bertakis KD, Fenton JJ, Franks P. 2012. Does applicant personality influence multiple mini-interview performance and medical school acceptance offers? *Acad Med.* 87:1250-9.
- Kelly ME, Dowell J, Husbands A, Newell J, Flynn SO, Kropmans T, Dunne FP, Murphy AW. 2014. The fairness, predictive validity and acceptability of multiple mini interview in an internationally diverse student population- a mixed methods study. *BMC Med Educ.* 14:267.
- Knorr M, Hissbach J. 2014. Multiple mini-interviews: same concept, different approaches. *Med Educ.* 48:1157-75.
- Krumpal I. 2013. Determinants of social desirability bias in sensitive surveys: a literature review. *Qual Quant.* 47:2025-2047.

- Liaison Committee on Medical Education. [Internet]. Functions and Structure of a Medical School; [cited 2016 Oct 9]. Available from: http://lcme.org/wp-content/uploads/filebase/standards/2016-17_Functions-and-Structure_2016-09-20.docx
- Mahon KE, Henderson MK, Kirch DG. 2013. Selecting tomorrow's physicians: the key to the future health care workforce. *Acad Med.* 88:1806-11.
- Mathers J, Parry J. 2009. Why are there so few working-class applicants to medical schools? Learning from the success stories. *Med Educ.* 43:219-28.
- Maudsley G. 2011. Mixing it but not mixed-up: mixed methods research in medical education (a critical narrative review). *Med Teach.* 33:e92-e104.
- McVeigh TP, Dunne FP. 2014. Gender differences in undergraduate medicine in Galway: a tale of two curricula. *Ir J Med Sci.* 183:103-110.
- Morgenstern H. 1982. Uses of ecologic analysis in epidemiologic research. *Am J Public Health.* 72:1336-44.
- Mustajoki M, Forsén T, Kauppila T. 2015. The Association between Patient-Reported Pain and Doctors' Language Proficiency in Clinical Practice. *Pain Res Treat.* 2015:7.
- Office of Minority Health - U.S. Department of Health and Human Services. [Internet]. Profile: Asian Americans; [cited 2016 Oct 9]. Available from: <http://minorityhealth.hhs.gov/omh/browse.aspx?lvl=3&lvlid=63>
- Oliver T, Hecker K, Hausdorf PA, Conlon P. 2014. Validating MMI scores: are we measuring multiple attributes? *Adv Health Sci Educ Theory Pract.* 19:379-92.
- Pampalon R, Hamel D, Gamache P, Philibert MD, Raymond G, Simpson A. 2012. An area-based material and social deprivation index for public health in Quebec and Canada. *Can J Public Health.* 103:S17-22.
- Park YS, Kim BS. 2008. Asian and European American cultural values and communication styles among Asian American and European American college students. *Cultur Divers Ethnic Minor Psychol.* 14:47-56.
- Phillips SP, Austin EB. 2009. The feminization of medicine and population health. *JAMA.* 301:863-4.
- Powis D, Hamilton J, McManus I. 2007. Widening access by changing the criteria for selecting medical students. *Teach Teach Educ.* 23:1235-1245.
- Raghavan M, Martin BD, Burnett M, Aoki F, Christensen H, Mackalski B, Young DG, Ripstein I. 2013. Multiple mini-interview scores of medical school applicants with and without rural attributes. *Rural Remote Health.* 13:2362.

- Rees EL, Hawarden AW, Dent G, Hays R, Bates J, Hassell AB. 2016. Evidence regarding the utility of multiple mini-interview (MMI) for selection to undergraduate health programs: A BEME systematic review: BEME Guide No. 37. *Med Teach*. 38:443-55.
- Reiter HI, Lockyer J, Ziola B, Courneya CA, Eva K. 2012. Should efforts in favor of medical student diversity be focused during admissions or farther upstream? *Acad Med*. 87:443-8.
- Renaud J-S, Cantat A, Lakhal S, Bourget M, St-Onge C. 2016. Sélection des candidats en médecine : validité prédictive des mini entrevues multiples en contexte francophone [Admission process of applicants in medicine: predictive validity of Multiple Mini Interviews in a French-speaking context]. *Pédagogie Médicale*. [Ahead of print] <http://dx.doi.org/10.1051/pmed/2016026>. French.
- Risager K. 2012. *The Routledge Handbook of Language and Intercultural Communication*. London: Routledge. Chapter 6, Linguaculture and transnationality: the cultural dimensions of language; p. 101-115.
- Roter DL, Hall JA. 2004. Physician gender and patient-centered communication: a critical review of empirical research. *Annu Rev Public Health*. 25:497-519.
- Smith H, Chen J, Liu X. 2008. Language and rigour in qualitative research: Problems and principles in analyzing data collected in Mandarin. *BMC Med Res Methodol*. 8:44.
- St-Onge C, Côté DJ, Brailovsky C. 2009. Utilisation du Mini Entrevues Multiples en contexte francophone: étude de généralisabilité [Using multiple mini-interviews in a French-speaking context: generalisability study]. *Mes Eval Educ*. 32:49-69. French.
- Statistics Canada. [Internet]. Table 2: Visible minority population and top three visible minority groups, selected census metropolitan areas, Canada, 2011; [cited 2016 1 October]. Available from: <https://www12.statcan.gc.ca/nhs-enm/2011/as-sa/99-010-x/2011001/tbl/tbl2-eng.cfm>
- Taylor CA, Green KE, Spruce A. 2015. Evaluation of the effect of socio-economic status on performance in a Multiple Mini Interview for admission to medical school. *Med Teach*. 37:59-63.
- Thomson D. 1995. Language, Identity, and the Nationalist Impulse: Quebec. *Ann Am Acad Pol Soc Sci*. 538:69-82.
- Uijtdehaage S, Doyle L, Parker N. 2011. Enhancing the reliability of the multiple mini-interview for selecting prospective health care leaders. *Acad Med*. 86:1032-9.

- United Nations. [Internet]. Composition of macro geographical (continental) regions, geographical sub-regions, and selected economic and other groupings; [cited 2016 Oct 9]. Available from: <http://unstats.un.org/unsd/methods/m49/m49regin.htm>
- van Nes F, Abma T, Jonsson H, Deeg D. 2010. Language differences in qualitative research: is meaning lost in translation? *Eur J Ageing*. 7:313-316.
- Wilson I, Harding D, Yeomans N, Griffin B. 2009. Lack of biases in the MMI. *Med Teach*. 31:959-60.
- Woolf K, Cave J, Greenhalgh T, Dacre J. 2008. Ethnic stereotypes and the underachievement of UK medical students from ethnic minorities: qualitative study. *BMJ*. 337:a1220.

Practice Points

- Demographics of applicants are associated with their MMI performance, although they may not be relevant for selection into medical school.
- Applicants and assessors perceive that the way they communicate in MMI stations may be modulated by some of these characteristics and by their life experiences.
- Monitoring of MMI station content and interviewer training may help reduce some implicit bias related to these demographics.

Notes on contributors

Jean-Michel Leduc, MD, MMed, FRCPC, is a medical microbiologist and infectious disease specialist, and is associate clinical professor at Université de Montréal. He has recently completed a Master's in Medical Education from the University of Dundee and has a research interest in the impact of admission tools on diversity.

Richard Rioux, MA, is a Senior Lecturer and PhD Student in Health and Society. He has completed a Master's in Health Communication from Université du Québec à Montréal. His research interests are environmental and occupational health, specifically medical resident's well-being and coping strategies during residency.

Robert Gagnon, MPsy, is a psychometrician and is head of the Assessment and Evaluation Office of Université de Montréal's Faculty of Medicine. He has worked in the medical field for many years. His research interests are mainly in the domains of development and validation of tests and assessment programs.

Christian Bourdy, MD, a general physician, is an associate professor at Université de Montréal and former vice-dean for undergraduate medical education. He is the chair of Université de Montréal admission committee and has been responsible since 2008 of the development and implementation of MMI across the three French Canadian Medical Schools.

Ashley Dennis, PhD, is a Lecturer at the Centre for Medical Education at the University of Dundee with a background in psychology. Her research and pedagogical interests centre on how educational structures support health professionals' development of resiliency and coping skills as they progress through their training.

Table 1: Characteristics of applicants

Characteristic	2014	2015	Total
Number of applicants	584	586	1170
Number of responders, no. (%)	568 (97.3)	531 (90.6)	1099 (93.9)
<i><20</i>	216 (38.0)	208 (39.2)	424 (38.5)
<i>20-24</i>	275 (48.4)	250 (47.1)	525 (47.8)
<i>25-29</i>	50 (8.8)	50 (9.4)	100 (9.1)
<i>>29</i>	26 (4.6)	17 (3.2)	43 (3.9)
<i>Missing</i>	1 (0.2)	6 (1.1)	7 (0.6)
Female, no. (%)	347 (61.1)	301 (56.7)	648 (59.0)
Applicants born in... no. (%)			
<i>North America</i>	471 (82.9)	451 (84.9)	922 (83.9)
<i>Asia (South, East, Southeast)</i>	19 (3.3)	25 (4.7)	44 (4.0)
<i>Europe</i>	28 (4.9)	22 (4.1)	50 (4.5)
<i>North Africa & Middle East</i>	32 (5.6)	22 (4.1)	54 (4.9)
<i>Other</i>	18 (3.2)	9 (1.7)	27 (2.5)
<i>Missing</i>	-	2 (0.4)	2 (0.2)
Self-declared ethnicity, no. (%)*			
<i>North American</i>	-	276 (52.0)	-
<i>White/Caucasian</i>	-	272 (51.2)	-
<i>Arab</i>	-	36 (6.8)	-
<i>Chinese</i>	-	29 (5.5)	-
<i>North African</i>	-	26 (4.9)	-
<i>Western European</i>	-	22 (4.1)	-
<i>Southeast Asian</i>	-	20 (3.8)	-
<i>Lebanese</i>	-	20 (3.8)	-
<i>Eastern European</i>	-	16 (3.0)	-
<i>Other/Quebecker</i>	-	7 (1.3)	-
<i>Other</i>	-	45 (8.4)	-
At least one parent born in... no. (%)*			
<i>North America</i>	419 (73.8)	379 (71.3)	798 (72.6)
<i>Asia (South, East, Southeast)</i>	42 (7.4)	49 (9.2)	91 (8.3)
<i>Europe</i>	56 (9.9)	56 (10.5)	112 (10.2)
<i>North Africa & Middle East</i>	60 (10.6)	73 (13.7)	133 (12.1)
<i>Other</i>	28 (4.9)	19 (3.6)	47 (4.3)
<i>Missing</i>	2 (0.4)	1 (0.2)	3 (0.3)
Linguistic factors			
French as most spoken language at home, no. (%)	448 (78.9)	429 (80.8)	877 (79.8)
French as first language, no. (%)	436 (76.8)	409 (77.0)	845 (76.9)
Socioeconomic factors			
Highest education level achieved by one parent, no. (%)			
<i>High school or less</i>	31 (5.5)	41 (7.7)	72 (6.6)

<i>College</i>	83 (14.6)	59 (11.1)	142 (12.9)
<i>Bachelor's degree</i>	189 (33.3)	187 (35.2)	376 (34.2)
<i>Master's degree</i>	118 (20.8)	116 (21.8)	234 (21.3)
<i>Doctorate</i>	141 (24.8)	109 (20.5)	250 (22.7)
<i>Missing</i>	6 (1.1)	19 (3.6)	25 (2.3)
Material deprivation quintiles, no. (%)			
<i>Q1 (least deprived)</i>	158 (27.8)	159 (29.9)	317 (28.8)
<i>Q2</i>	85 (15.0)	83 (15.6)	168 (15.3)
<i>Q3</i>	69 (12.1)	82 (15.4)	151 (13.7)
<i>Q4</i>	75 (13.2)	70 (13.2)	145 (13.2)
<i>Q5 (most deprived)</i>	52 (9.2)	52 (9.8)	104 (9.5)
<i>Missing</i>	129 (22.7)	85 (16.0)	214 (19.5)
Family income category, no. (%)			
<i><\$100 000</i>	-	198 (37.3)	-
<i>\$100 000 to 250 000</i>	-	200 (37.7)	-
<i>> \$250 000</i>	-	86 (16.2)	-
<i>Missing</i>	-	47 (8.9)	-
Size of community of residence, no. (%)			
<i>Large city (>100 000)</i>	490 (86.2)	452 (85.1)	942 (85.7)
<i>Medium city (10 000 – 100 000)</i>	48 (8.5)	32 (6.0)	80 (7.3)
<i>Small city, rural area (<10 000)</i>	23 (4.0)	41 (7.7)	64 (5.8)
<i>Missing</i>	7 (1.2)	6 (1.1)	13 (1.2)

***For these categories, the applicants could choose more than one answer explaining why the percentages do not add up to 100%.**

Table 2: Linear regression model including interaction between gender and spoken language

Variable	<i>B</i> (95% CI)	<i>SE B</i>	β	<i>p</i> value
Constant	231.91 (224.81, 239.01)	3.62	-	< .001
Age category (reference <20)				
20-24	0.347 (-3.62, 4.31)	2.02	0.01	.864
25-29	11.91 (5.12, 18.70)	3.46	0.11	.001
>29	-8.14 (-17.93, 1.64)	4.99	-0.05	.103
Female	-4.55 (-12.93, 3.83)	4.27	-0.07	.287
Parental origin (At least one parent born in...)				
<i>Asia (East, South, Southeast)</i>	-14.26 (-21.50, -7.02)	3.69	-0.12	< .001
French as most spoken language at home	4.97 (-2.36, 12.30)	3.74	0.06	.184
Female* French as most spoken language at home	14.33 (4.98, 23.68)	4.77	0.22	.003

Table 3: Characteristics of participants to the qualitative strand

	Semi-structured interviews (applicants, n=19)	Focus groups (assessors, n=8)
Females, no. (%)	8 (42.1)	3 (37.5)
French as first language, no. (%)	15 (78.9)	7 (87.5)
French as most spoken language, no. (%)	17 (89.5)	8 (100.0)
Born in North America, no. (%)	17 (89.5)	7 (87.5)
Self-identified as “White/Caucasian”, no. (%)	14 (73.7)	5 (62.5)

Table 4: Relevant quotes

1	If I were just graduating from “cégep” [college] and I came to do the interviews and I knew I’d be thrown off balance like that, [...], I’d have been more stressed; you get less confident when that happens... (Applicant #J13, Male, Canadian-born, native French speaker)
2	A 25-year-old candidate explaining his social involvement, versus a 18-year-old explaining a comparable level of social involvement, it seems to me that in an MMI, the more you are... the more life experience you have, the better you’ll deliver that explanation, and the assessor may be more impressed (Assessor #M4, MD, Male, Canadian-born, Native French speaker)
3	Me, I’m really... I’ve been lucky all my life... my family is financially well-off, I was born in Ontario, after that I lived here in Quebec, in a country where, well, I got an education, my parents always supported me financially, I did plenty of activities, really grew as a person through a lot of things I did. (Applicant #J15, Female, Canadian-born, Native French speaker)
4	If somebody wasn’t able to volunteer and then they don’t explain clearly why, because they don’t feel like telling me they don’t have a lot of money and they need to work all the time - and that’s actually why they can’t do any volunteering - well that person may be at a disadvantage compared to others and I might never know it. (Assessor #M3, MD, Male, Canadian-born, Native French speaker)
5	Hum... yeah, I think that... we express ourselves differently, and, we, we interact with others in a different way. And... regarding empathy, it may not be as easy for a guy to show it [...] they [women] probably have an advantage; it’s easier for them to express their feelings as well as empathy. (Applicant #J5, Male, Canadian-born, Native French speaker)
6	[Describing a station] there was a situation where I was with a girl and she was my... my flatmate, and we both got into medical school. She told me the news, and I just naturally gave her a hug, but if I had been a guy, I would have... I don’t know, I’m not a guy (laugh), but if I were a guy, I would have kept my distance, I would have said “congratulations” and shook her hand. (Applicant #J9, Female, Canadian-born, non-Native French speaker)
7	And especially when I was next to the door and I was reading the question, I read the question and there were words that I didn’t understand... I wasn’t able to get the whole meaning. (Applicant #J9, Female, Canadian-born, non-Native French speaker)

8	They can't always find the right words, it impairs the fluency that we would have with other candidates, and that could place them at a disadvantage compared to others. (Assessor #M3, Male, Canadian-born, Native French speaker, MD)
9	...it's part of the deal, and it will remain a flaw, if it isn't... so, maybe I'm wrong, but I have a tendency to assess "as is", without always trying to translate the words. (Assessor #M4, Male, Canadian-born, Native French speaker)
10	The fact that I come from an immigrant family; since I was young, it has always been about open-mindedness, integration, just learning to respect other people, to see the beauty in other cultures, so it really helped me to answer the question, because I have a background with that. (Applicant #J6, Female, foreign-born, non-Native French speaker)
11	It happened to me a couple of times, maybe it's just a random thing, but a couple of times with candidates from Asian origins, where, hum... it's hard to tell if it's because their affect is different or if they're just very shy. (Assessor #M4, Male, Canadian-born, French-speaker, MD)

Table 5: Summary of findings according to applicants' characteristics

Characteristic	Association observed (Q1)	Barriers, enablers and possible explanations (Q2)
Age	Older candidates (25-29 years) had a higher score than younger candidates	Maturity and greater life experience perceived as enablers by providing more content to candidates, improving the "message".
Gender	Females, especially French-speaking ones, had a higher score than males	Females may be able to show more empathy and listening skills. They may benefit from an implicit positive prejudice from assessors
Ethnocultural background	Candidates with an Asian background (East, South and Southeast Asia) had a lower score.	Differences in communication style may act as a barrier. Lack of cultural awareness from assessors may act as barriers by creating "psychological noise".
Language	Candidates who do not speak French regularly at home had a lower score.	Issues with understanding instructions, misunderstandings ("semantic noise"), fluency, stress management and time pressure.
Socioeconomic status	Candidates from high-income families had a higher score than the others – difference not visible when using area-based deprivation index.	May be caused by more numerous or more diverse life experiences, because of greater parental financial support, therefore improving the "message".